Sedimentation Volume of Powders

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16. Plasticity of Bentonite Clay

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It was reported recently that the bentonite clay swelled with water showed peculiar slip bands under compression by two parallel planes [Goto and Hirai: This Bull. **20** 48 (1940)].

The direction of the slip bands corresponds to that of the maximum shearing stress which inclines at 45° in the direction of the force applied. When a block of clay is closed in a test box of shearing (a soil testing apparatus) under a vertical (P) and a horizontal shearing force (F) the threshold value (F_0) of the shearing is generally given by the relation

$$F_0 = P \tan\varphi + \nu \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (1)$$

where φ is the angle of internal friction and ν is the cohesion force. For the bentonite clay swelled with water, it was confirmed that $\varphi = 0$ or $F_0 = \nu$. And ν changes its value with the amount (W) of water added, holding the relation

$$\nu = Ae^{-bw} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (2)$$

where A and b are constants. The analogous relation has been found between the yield value (S_f) of plastics and the amount of the plastizer [Kanamaru: Chem. and Chem. Ind.; **2** 246 (19449)). Thus it is suggested that the threshold value of shearing stress or cohesion force ν, corresponds to the yield value and water acts as a plastizer in this case.

It was found that when the aqueous solution of NaCl or alcohol at various concentration is used as a plastizer instead of water, the relation (2) is somewhat modified. This means the decrease of the hydrophilic property of the bentonite.

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17. Sedimentation Volume of Powders

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In order to investigate the lyophilic properties of various powder in benzene, the sedimentation velocity v and its final volume per gram V_1 were observed. v of ZnO_2, starch or carbon black in benzene begins to decrease steeply at the sedimenting volume V_2, which is several times as large as V_1, and when V_2 is reached, the rest angle appears and increases rapidly as sedimentation proceeds. This means that the interaction or the friction between the particles begins to

work at the sedimenting volume V_2. The values of V_1 and V_2 may be both related with the lyophilic properties of the powder. For example dry starch in benzene shows dilantancy and gives small values of V_1, and V_2, while wet starch in benzene which is thixotropic gives large values of V_1 and V_2. Further, ZnO in benzene which is also thixotropic gives large values of V_1 and V_2.

The rigidity of those systems at V_1 measured by Schwedoff's method showed very large values, but their limits of rigidity were very small comparing with the gel of gelatine at the volume concentration.

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18. Vapor Pressures and Inflammation Limits of Organic Volatile Substances

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Vapor pressure (p) of camphor, naphthalene and phthalic acid anhydride were measured by the flow method. The relation of p can be given approximately as follows:

$$P=\frac{62.4TPW}{PMV+62.4TW} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (1)$$

where T is the absolute temperature of the vapor, P the atmospheric pressure, W the weight of the volatile substance sublimed, and M the molecular weight of the substance. Linear relations between $\log p$ and $1/T$ were obtained for those three kinds of volatile substance. Accordingly, the heat of vaporization (L) can be given by Clausius-Clapeyron's equation

$$\log p=\frac{a}{T}+b, \qquad \text{where } a=-\frac{L}{2.3R} \text{ and } \qquad b=\text{const.}$$

a, b and L are shown in the Table 1.

Table I.

	a	b	L Kcal/mol	
			obs	from literature
Camphor	−2.83	8.87	12.95	12.43
Naphthalene	−2.69	9.39	12.32	11.31
Phthalic acid anhydride	−3.30	8.89	15.08	13.12

Next, the lowest temperature for inflammation or the flash point were observed in the air saturated with the vapor. The inflammable mixtuare were ignited in a large test tube (2.9×20cm) with the spark excited by an induction coil at various temperatures. From the atmospheric pressure and the vapor pressure at the lowest temperature for ignition, the limit (C_0) of inflammation was calculated. According to the theory proposed by Goto